Journal of Choice Modelling

Journal of Choice Modelling, 2(2), pp 173-199
www.jocm.org.uk

The impact of fixed and variable costs on household car ownership

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Received 30 January 2009, revised version received 14 September 2009, accepted 19 October 2009

Abstract

Car purchase taxes in The Netherlands are among the highest in the EU. The Dutch government plans to gradually replace car purchase and ownership taxes by a national road user charging system (kilometre charge) in the period 2012 to 2016. As a result, new and second hand car prices in the Netherlands will drop up to 30%. Relatively little research has been conducted on the impacts of such large price changes on car ownership. Reduced car prices are likely to lead to an increase in car ownership. But consumers could also refrain from buying extra cars when they consider the extra operating costs resulting from the kilometre charge. This paper presents one of the few empirical studies to examine the effects of both (large) fixed and variable car cost changes on both car ownership and use. An internet survey among Dutch households was designed and conducted including stated intentions and stated preference experiments. We investigated whether households react more to present one-off fixed costs than to recurrent variable costs, for various specifications of car costs. Model analysis was conducted to derive fixed and variable price elasticities for private car ownership and effects of the kilometre charge. The study shows in their car purchase decisions, households react more strongly to a change in euro per year in fixed car costs than to a euro per year in variable car costs. Abolishing the Dutch car purchase tax while at the same time introducing a kilometre charge will lead to 2% rise in car ownership on the short to medium run (1-5 years).

Keywords: road pricing, car ownership, car use, discrete choice models, fixed and variable car costs

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ISSN 1755-5345

1 Introduction

The Dutch government has decided to gradually replace the existing car purchase tax (called 'Belasting van Personenauto's en Motorrijwielen', BPM) and the annual road taxes (called 'Motorrijtuigenbelasting', MRB) by a national system of kilometre-based charging, in the year 2012 to 2016. The price per kilometre driven is to be differentiated by location, time of day and environmental performance of the vehicle. The new charging scheme will be cost neutral for the average car driver.

The reduction of the fixed car costs may have unintended consequences in the form of rising car ownership. Car purchase taxes in The Netherlands are among the highest in the European Union (e.g., see Kunert and Kuhfeld 2007). Abolishing Dutch car purchase taxes will reduce prices for new and second hand cars by up to 30%. Here, we assume decreases in the prices of new cars will be equal to the former tax, and prices on the second hand market will follow those on the market for new cars. This is probably an overestimation of the price effect. Price changes will likely not be completely passed through to consumers. International literature on this (Berry *et al*. 1995, 2004) suggests that mark ups may change as well. Goldberg and Verboven (2004) show that markup adjustments explain low pre-tax prices in countries with high purchace taxes. In countries with high car purchase taxes, such as Denmark and the Netherlands, most manufacturers set pre-tax list prices at a low level, arguing that this is necessary to make the after-tax prices affordable (European Commission, 2001-2008). The standard deviation of new car prices on national markets has been about 6-7% in the past years (European Commission 2001- 2008). It it likely that pre-tax car prices in the Netherlands will increase by a few percent when purchase taxes are abolished.

The impacts of several pricing variants have been examined using the Dutch national transport model (LMS; see Gunn 1999; Daly and Sillaparcharn 2008) to obtain impacts on car use and a national car market model (DYNAMO; MuConsult 2008) for impacts on the number of cars in the household and vehicle type choice. These models show that on the long run car ownership is likely to increase (by 4-5%) and overall car use is strongly reduced (by 10-15%). The model results seem to imply that car owners are myopic: they are more sensitive to a current reduction in (car purchase) prices than to a future stream of price increases (the kilometre charge). However, it can be questioned whether the car ownership model, which is based on revealed preference data, will be capable of providing the proper behavioural effects of such a major car price change.

This paper reports the outcomes of a research project carried out by Significance for the Netherlands Environmental Assessment Agency, to corroborate the above forecasts for the car ownership effects of the road pricing scheme: what are the elasticities of the changes in BPM and kilometre costs on car ownership? Furthermore, the impacts on vehicle type choice and annual household car use are also examined. One of the issues that will be investigated in this paper is whether consumers are myopic.

In the literature there are many results on the effects of changes in purchase prices or fixed car costs on car ownership (for an overview of car ownership models, see De Jong *et al*. 2004). Several studies also give the impact of fuel efficiency, fuel prices or variable car costs on car ownership or choice of vehicle type (e.g. Dargay and Gately 1999; Dargay and Vythoulkas 1999; Hensher and Greene 2000; Brownstone *et al*. 2000; Page *et al*. 2000; Potoglou and Kanaroglou 2007; Mueller and de Haan 2008). The literature on the effects of the fuel price or variable car costs on car use is even more extensive (reviews of elasticities can be found in de Jong and Gunn 2001; Graham and Glaister 2004). These studies usually do not include an impact of fixed costs on car use. Studies that give the effects of both fixed and variable car costs on both car ownership and use – from a joint model of car ownership and use; estimated on a single data set- are quite scarce. Among the few examples are De Jong (1990, 1996, 1997), Bunch *et al*. (1996) and Rouwendal and Pommer (2004).

The paper presents the design of a revealed preference/stated intentions/stated preference (RP/SI/SP) survey among 2,500 Dutch households (1,000 without a private car; 1500 with one of more private cars), and the results of model estimation on the data collected. The survey collects information on the current car ownership of the household. In a first experiment, households are asked to state their car purchase intentions under various scenarios. In the second experiment, the same households are asked to choose between different car types, conditional on a car purchase. There are two different versions of the questionnaire depending on the formulation of the costs attributes (all in terms of euros per year versus choice situations using fuel efficiency and purchase price as attributes).

On the basis of this RP/SI/SP data set models are estimated:

- Discrete choice models for the number of cars in the household;
- Discrete choice models for car type choice, using the same distinction as above; and
- Regression equations (with endogeneity correction) for the annual car use.

In these models we distinguish between the two versions of the questionnaire, to investigate whether the way the cost attributes are presented lead to different outcomes.

In section 2 of this paper, we present a theoretical model (from micro-economic theory) that shows how fixed and variable car costs can influence car ownership and use differently. The design of the RP/SI/SP is described in section 3. In section 4 of this paper, we present the estimation results for different model specifications. In section 5, we give application results; especially fixed and variable car costs elasticities of car ownership and use, which will be compared against the literature. Section 6 contains a summary and conclusions.

2 A theoretical model of household car ownership and car use

In a model in which the utility of a durable consumption good only consists of user value, the fixed car cost will play a fundamentally different role than variable car cost. A variabilisation measure that is cost-neutral for an average consumer can then, also under rational behaviour, lead to changes in car ownership and use (de Jong 1990). This is worked out below.

In a micro-economic model for the choice of the annual amount of car kilometres (with variable car costs per kilometre as their price) and all other goods and services (price: unity), changes in fixed and variable costs have a different impact on car ownership and use (de Jong 1990; see Figure 1). In the situation before the variabilisation measure (situation 0), the budget line for some household ran from its income at point Y (without a car) down along the vertical axis to Y-C_0 (with a car; C stands for fixed costs per year), and then it slants down, depending on the variable

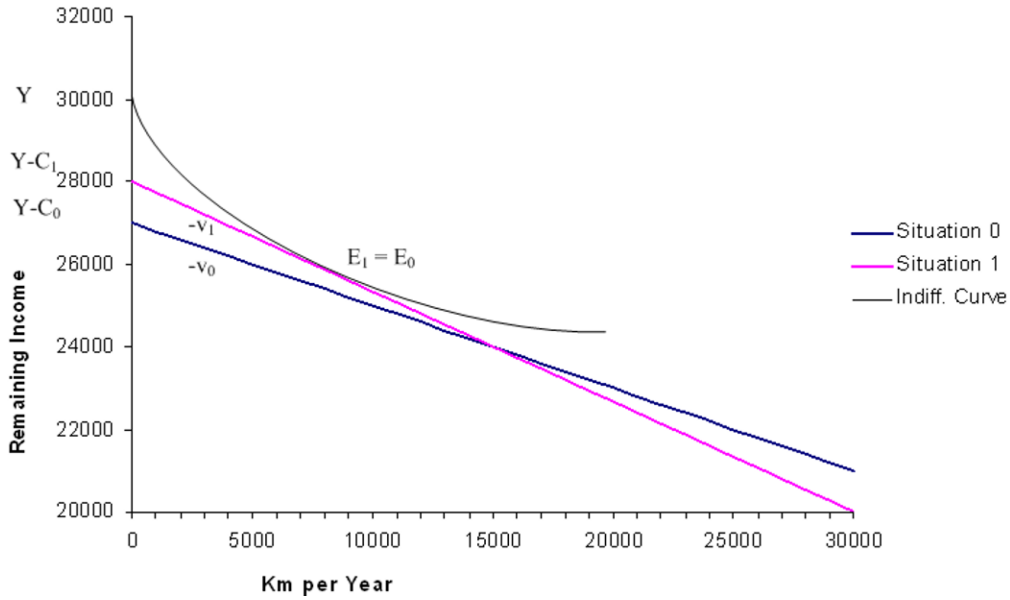


Figure 1. Budget equations and indifference curve for car kilometres and other goods

costs (per kilometre) v_0. A change in variable car costs will change the slope of the slanting part of the budget line. Changes in fixed car costs will change remaining income (income minus fixed costs) and thus move the slanting part of the budget line up or down, without changing the slope. It is likely that changes in fixed costs will have a relatively large impact on car ownership and changes in variable costs a relatively large impact on car use. For instance a decrease in the fixed cost per year of 500 euro can induce a non-car-owning household to buy a car, even though the variable car costs would increase by 500 euro per year at the national average annual car use. This household would then drive fewer than average kilometres per year.

For the household in Figure 1, in situation 0 (before the policy), the highest indifference curve that can be reached is drawn. It is reached at point Y: the household will not own a car. In situation 1, the fixed costs have been reduced considerably, and the variable costs have risen (15,000 km is the break-even point). Now the household can reach the same indifference curve not only at Y, but also at a positive car use level (around 8,000 km, clearly below 15,000 km): it will be indifferent between owning and not-owning a car. If the variabilisation measure would be marginally greater than in situation 1, the household would prefer to own a car. This discussion refers to a single household, choosing between zero cars and one car. The model can be generalised to include multiple car ownership (de Jong 1997; Rouwendal and de Borger 2009). Different households will have different incomes and different preferences. The population can be depicted as a series of graphs as in Figure 1.

3 The RP/SI/SP survey

3.1 Data requirements from model specification

The main research question deals with the impact of the car purchase tax (BPM) and of the future kilometre charge on the number of cars in the household. To answer this question, a model is required of the form:

$$N = f(M, T, \ldots) \tag{1}$$

where:
N: the number of cars in the household: $N \in [0, 1, 2, 3+]$,
M: level of the BPM, and
T: level of the kilometre charge.

The effect on households of abolishing the BPM will run through the purchase prices on the markets for new and second hand cars (including the effect on the trade-in values). Taking this into account, the model can also be specified as:

$$N = g(P_n, P_t, K_n, K_t, \ldots) \tag{2a}$$

where:
N: the number of cars in the household $N \in [0, 1, 2, 3+]$,
P_n: purchase price of a new car,
P_t: price of a second hand car,
K_n: kilometre charge new car, and
K_t: kilometre charge second hand car.

If we would assume that the impact of the change in purchase prices would run through the annual fixed costs (including depreciation, insurance, ownership taxes, repairs) and that the effect of the kilometre charge would run through the annual operating costs (sum of fuel cost and kilometre charge), the model can also be specified as:

$$N = h(F_n, F_t, V_n, V_t, \ldots) \tag{3a}$$

where:
N: the number of cars in the household $N \in [0, 1, 2, 3+]$,
F_n: fixed cost of a new car,
F_t: fixed cost of a second hand car,
V_n: operating cost new car, and
V_t: operating cost second hand car.

The functional form of f, g of h could be (mixed) multinomial logit (MNL), but also ordered logit (OL) or probit. Bhat and Pulugurta (1998) found in an application to car ownership that MNL performed better than OL.

In equation (3a) all monetary attributes of the car ownership model will use a common basis which is the cost in euro on an annual basis. Presenting the policy measures in this way to the respondents boils down to imposing a large degree of rationality, in the sense that specific rational calculation rules are used to make the attributes comparable (however this does not guarantee that respondents will process the outcomes rationally). In this paper we examine two different models, and compare the outcomes. Firstly, a model is examined where the policy measure is presented in terms of a non-recurrent change in purchase price at the beginning of car holding duration on the one hand and recurrent kilometre costs on the other hand, and leave it to the respondent whether he or she will bring these under a common denominator. Secondly, a model is examined where all monetary attributes are expressed in euro per year.

Specification (2a) and specification (3a) can be seen as two competing research methods. Both can yield the requested elasticities; the question is whether one is willing to make the assumption (necessary for specification (3a)) that abolishing the BPM and compensating this in the user charge will run through annual fixed and variable costs. Because it is not a priori clear whether both specifications will lead to different outcomes, or indeed what the best specification would be, in this study, we decided to collect experimental data and estimated models both with and without these assumptions. We tested specification 2, with a direct effect of purchase price and kilometre charge on car ownership, as well as specification 3, where the effects run through the fixed and variable cost variables.

The models (1) - (3) are static car holdings models. In the choice experiments, in the survey, households are asked about changes (transactions) in their car ownership situation, relative to the current situation (transaction specification), such as: purchasing a car, replacing a car or disposing of a car. The models that are estimated on these data can also give impacts on the number of cars owned, but because of the transaction specification, they come closer to the real choice process of the households. So the two specifications used for car ownership are:

$$\Delta N = g(\Delta P_n, \Delta P_t, \Delta K_n, \Delta K_t, \ldots) \tag{2b}$$

$$\Delta N = h(\Delta F_n, \Delta F_t, \Delta V_n, \Delta V_t, \ldots) \tag{3b}$$

where:
ΔN: change in household car ownership situation (transaction decision) and Δ in RHS variables indicates changes in the respective variable (e.g. change in fixed car cost).

Given that the kilometre charge has not yet been introduced in the Netherlands, preferences of respondents can only be obtained from experimental data, such as stated preference (SP) surveys.

For obtaining trade-off values (ratios between model coefficients), stated preference surveys (of stated intentions surveys) might be sufficient, but the error variance of SP surveys is likely to differ from that from observed choices (in the SP many things remain constant that vary in the real world and the other way around). Consequently, models based solely on SP data are not appropriate for forecasting (see Bradley and Daly 1997). In this study, the focus in terms of required outcomes is on elasticities, which are a form of forecasting. Therefore in this study we combine SP data with revealed preference (RP) data and models. Models on combined SP and RP data are estimated, in which the SP scale parameter is calibrated to that in the real world data, to correct for the difference in the error variances.

3.2 Population and sample

The survey population consists of all households with one or more driving licences living in The Netherlands. We distinguish between households without private cars and households with one or more private cars. It seems likely that both groups will react differently to changes in BPM (fixed costs) and kilometre charging (variable costs), because the choice options are different (shift from 0 to 1 car; an extra car), and because for households with a car there can also be an impact of the policy measures on the trade-in value of the present car(s). Twenty two percent of all Dutch households do not own a car. Very little is known about their propensity to buy a car if the BPM would disappear and the purchase prices would drop significantly. Because we want to estimate separate models for this group (for which a minimum sample size is required), we use a stratified random sample in which households without a private car will be oversampled. The strata are:

- Households without a private car: target 1000 successfully completed interviews;
- Households with one or more private cars: 1500 households successfully completed interviews.

Within each of these two groups, 50% of the interviews was done using experiments with purchase price and kilometre charge as attributes and 50% with annual fixed and variable costs as attributes (allocated randomly). So the targets numbers for the survey were 500/500 for the households without a private car and 750/750 for the car-owning households.

It is very unlikely that abolishing the BPM will induce households without a driving licence to acquire a driving licence, so that they could buy and drive one of these cheaper cars. Therefore households without a driving licence were excluded from the survey. This study investigates the reactions of households. Decision-making about company/lease cars to a large extent is the responsibility of the employer. Therefore the experiments in the survey are about private cars not company cars or lease cars.

The survey was carried out as an internet survey, using the internet panel of EuroClix/PanelClix. The respondent is a person that would be involved in decision-making about a future car purchase of the household. In Table 1 the number of successfully completed interviews is compared against the targets (in estimation we use data from both the second pilot and the full survey, see section 3.3). The data collection for the full survey took place in the period 5-12 December 2008.

Table 1. Number of successfully completed interviews per segment (main survey and 2nd pilot)

Segment		Interviews	Target	Difference	Made target?
A	No car, purchase price and km charge	525	500	25	Yes
B	No car, fixed and variable costs	523	500	23	Yes
C	Car, purchase price and km charge	839	750	89	Yes
D	Car, fixed and variable costs	832	750	82	Yes
	Total	2719	2500	219	

A number of observations were discarded because of missing or inconsistent data. The models are estimated using a data set containing 2446 respondents (459, 462, 766 and 579 respectively in the segments A, B, C and D).

3.3 The questionnaire

The questionnaire consists of five parts. The first part contained questions about characteristics of the persons and cars in the household, i.e. questions about the number of driving licences, number of cars (private and company/lease), car type for up to three private cars (age, size, make, model, fuel type, weight class, fuel efficiency, kilometres driven) of the cars in the household, age, gender and occupation for up to five persons in the household. In the last part of the survey additional questions were asked about the zip code of the household, availability of parking licences, household net income per year.

Stated Intentions Experiment - car ownership
The second part of the survey contained a Stated Intentions (SI) Experiment. In this experiment, the respondent is presented with possible future situations. We call this first experiment a Stated Intentions experiment and not a Stated Choice (SC) or SP experiment, because responders were presented one situation at a time (not several alternatives each in terms of multiple attributes). Each situation is described in terms of attributes like the purchase price for a new car and for a five year old car and the kilometre charge, and then we ask what the household of the respondent would do in this situation (buy an extra new car, do nothing, etc.). In all experiments in this survey we made clear to the respondents that annual road taxes are also fully abolished. In order to get sufficient price variation, we do not always present situations where all the BPM has been taken away, but we present situations with large reductions in the BPM and with abolishing the BPM altogether. Also, it was emphasised that the changes refer to new/used cars and that non-presented attributes remained the same.

These SI experiments thus include many attribute values per 'choice situation'. Each of these was presented as a single screen on the PC. Recent SP research has emphasised the need to include not just two or three attributes, but considerably more, if these attributes are relevant to the decisions at hand. For the SI experiment we used a full factorial orthogonal design.

For segments A (no car) and C (car) the SI experiment contained the following attributes:

- Purchase price of new cars (% reduction and absolute example for an average new car);
- Purchase price of second hand cars (% reduction and absolute example for an average five year old car);
- Only for segment C: Trade-in value for present car, or car that would be replaced first (% reduction and absolute levels then and now)
- Kilometre charge (eurocent/km).

For segments B (no car) and D (car) the SI experiment contained the following attributes:

- Ownership costs (including depreciation) of new cars (% reduction and absolute example for an average new car);

- Ownership costs (including depreciation) of second hand cars (% reduction and absolute example for an average five year old car);
- Only for segment D: Ownership costs for present car, or car that would be replaced first (% reduction and absolute levels then and now);
- Usage costs (including kilometre charge) of cars (% increase and absolute example for an average car);
- Only for segment D: usage costs (including kilometre charge) of present car (% increase and absolute levels then and now).

The possible answer categories differ between segments. The possible answers for households without a car (segments A and B) to the question 'would your household in this situation buy a car?' were (a) Yes, a new one, (b) Yes, a second hand one, (c) No and (d) Don't know. The possible answers for households with a car (segments C and D) to the question 'what would your household do in this situation?' were: (a) get rid of the present car, don't replace it, (b) keep the present car, don't buy a new one (=the do-nothing opton), (c) keep the present car, buy an extra new car, (d) keep the present car, buy an extra second hand car, (e) replace the present car by a new one, (f) replace the present car by a second hand one, of (g) don't know.

This experiment was tested in two subsequent pilots, each containing four times 50 interviews. We decided to do a second pilot because after the first pilot the SI experiment had been changed substantially. The resulting car ownership models had correct and significant signs for most variables. After the second pilot, the 'Don't know' option was taken out, because a sizeable share (20%) of the respondents was choosing this answer for all nine choice situations. In the results for the estimated models later on in this paper, there will be some observations for the 'Don't know' option, because the estimation took place on the combined data from the second pilot and the full survey.

Stated Intentions Experiment - car use

In part three of the survey we asked how many kilometres the household would drive per year in each of the cars that it would own in case of lower purchase prices and higher usage cost (as presented in part 2).

Stated Preference experiment

In this second experiment, each household is asked to choose between two cars A and B, described in terms of a number of vehicle attributes. For segments A and C the attributes in the SP experiment were: (1) size class of car (illustrated by three photos per size class), (2) age of the car, (3) purchase price (in euro), (4) car fuel type, (5) car fuel efficiency, (6) fixed costs per year (excluding depreciation), and (7) kilometre charge (eurocent/km).

For segments B and D the following attributes were included: (1) size class of car (illustrated by three photos per size class), (2) age of the car, (3) car fuel type, (4) fuel costs per year, (5) fixed costs per year (including depreciation) and (6) kilometre charge per year.

Each respondent had to provide his/her preference in twelve binary choice situations. The possible answers are: (1) Car A, (2) Car B, (3) A nor B and (4) Don't know.

For the SP experiment we used a design in which a limited amount of correlation (e.g. positive correlation between age class and fixed cost, excluding depreciation) was allowed. This increases the degree of realism of the experiment in the eyes of the respondent. The amount of correlation was tested and adjusted in the two pilots.

4 Model estimations

4.1 Household car ownership models on the SI experiment data

Multinomial logit models were estimated using Alogit. In these models, one of the alternatives (the option 'No' in segments A and B and the do-nothing option in segments C and D) has a utility of 0 (reference alternative). The estimation results for this experiment were of about the same quality when including all observations or when only including the respondents who 'traded' (i.e. who gave different responses to the choice situations instead of nine times the same response). Here we present the results for all observations, using the data from both the full survey and the second pilot. Note that we only present coefficients that are significantly different from zero. Alternative specific constants are presented irrespective of their *t*-ratio.

Table A1-1 (Annex 1) presents the estimation results for segment A (households without a car, without transformation of variables to cost per year). The reference alternative is not buying a car. We expect a negative impact of prices of new cars on the probability of choosing to buy a new car, as well as a negative impact of used car prices on the propensity to buy a second hand car. This is also what we find in estimation. The kilometre charge has a negative impact on car ownership. We also allow for observed heterogeneity between respondents in the coefficients of purchase price and the kilometre charge. Car ownership in the highest income segment is not sensitive to changes in usage cost. For instance the impact of the new car price on the probability of buying a new car declines as household income increases. The impact on car ownership of a change in the new car purchase price of one euro per year is a factor 2.0 (for the highest income group, using the coefficients -3.16E-4 + 1.61E-4) to 4.1 (lowest income group, using the coefficient -3.16E-4) times as large as that of a change in the kilometre charge of a euro per year. This factor is estimated assuming a depreciation period of 10 years, no capital costs and an average car use level of non-car-owning households of 11,350 km which would drive if they would buy a car. For second hand cars this factor is 5 to 6. In this experiment, the respondents seem to be showing myopic behaviour. However, we will come back to this when discussing segment B.

In segment B (households without a car, all cost variables presented as annual amounts), the ownership costs and usage costs for new and second hand cars have the right sign (see Table A1-2). There is also a positive effect of second hand ownership costs on new car purchases and the other way around. For new cars, the impact of ownership costs per euro per year is around ten times as large as the impact of usage cost. For second hand cars this ratio is around nine. However, the fact that for segment B both attributes were presented in euros per year makes myopic behaviour unlikely. A more likely explanation for the grater car ownership sensitivity to fixed costs than to variable costs is the fact that a household can avoid the fixed car costs or add such costs to its expenses by selling a car or by buying an extra car respectively. The variable car costs cannot so easily be avoided or added to the household expenses by household changes in car ownership. If the household sells a car (without replacement), it still has to travel (e.g. using another car or public transport), and will incur (variable) travel costs. An additional argument is the uncertain (and largely exogenous) nature of the variable costs. The future variable costs depend on the fuel prices in the future and on the introduction of kilometre charging and the kilometre rate. It seems likely that households will react less to variables which are more uncertain

In Table A1-3 (Annex 1) are the results for segment C (households with one or more private cars, no common basis for the cost variables). Here the reference alternative is do nothing (keep current car, no purchase). The purchase price of the new car has a negative influence on the probability of buying a new car (both for the situation where it would be an extra car and where it would replace a current car). Similar results are found for the used car purchase price. Additionally we now also have the influence of the trade-in value of the present car (that would be replaced first), which increases the likelihood of replacement (by a new or used car). The impact of a euro per year change in the purchase price (new or second hand) is for most types of households 2-5 times as great as that of a euro per year for the kilometre charge: car ownership behaviour again seems myopic. For calculating these ratios we used a depreciation period of 10 years, no capital costs and an average annual car kilometres of 15,200. Car use is higher for households already owning a car than for households just entering the car market.

For segment D (households with one or more private cars, all cost variables on an annual basis) we also obtain correct signs (also see Table A1-4). On a euro per year basis, the ownership costs for new and second hand cars are around 1.3 times as important as the usage costs (but the variable cost coefficient is not quite significant for this segment.

4.2 Regressions for annual car use

For the segments C and D we have RP observations on the annual number of kilometres driven in each of the (first three) private cars of the household. Ordinary regression models were estimated explaining the kilometres driven per car and household summed over the private cars it owned. The latter models were clearly better in terms of statistical fit. These models were then re-estimated using instrumental variables for remaining income (=income minus fixed car costs) and variable costs (in a two-stage least squares estimation) to correct for the endogenous nature of these variables, that are explanatory variables in the car use equation. Fixed and variable costs are not truly exogenous here, because they are determined to a large extent by the vehicle type choice of the household. The linear model outperformed the double logarithmic (constant elasticity) model here (the constant remaining income elasticity of car use from this model was 0.68). Variable costs has a negative impact on car use (though not significant at 95%), and remaining income and household size have a positive influence (also see Annex 2). The variable (or fuel) cost elasticity of car use (at the average attribute levels) is -1.22 (however this is based on a non-significant coefficient, so we need to be careful here; a coefficient of 0 is also within the 95% confidence interval). The remaining income elasticity is 0.86, the income elasticity 1.01 and the fixed cost elasticity is -0.16.

In part 3 of the questionnaire we asked the respondents how many car kilometres they would drive in each car in a situation with lower purchase prices and higher usage costs (as presented in the SI experiment). We asked this conditional on each of three specific car transactions (buy an extra car, get rid of a car, replace a car). The total number of car kilometres in these hypothetical situations can be compared against the observed total number of car kilometres.

On average, households in segments A and B (who have no observed car use) would drive 11,350 km per year, if they would buy a car. This is considerably lower than the observed household average for segments C and D of 19,800 km (including use of one to three cars), or the average number of kilometres driven per car of 15,200 km. This is in agreement with a priori expectations; the theoretical model of section 2 assumes that new entrants to the car market drive less than average. The responses on car use for Segments C and D are shown in Table 2.

From Table 2 we conclude that if household car ownership would increase, total car use would increase as well. If car ownership would decrease, so would car use. In the (most likely) situation of no change in the number of cars in the household (one car replaced by another), the total number of car kilometres drops considerably – as a result of the increase in usage costs.

4.3 Joint RP/SI model for car ownership

The SI car ownership model for segments A, B, C and D (with variable and fixed car costs) was combined with a car ownership model on the RP data (for all households in the estimation sample). We carried out a joint estimation here, because we want to use the estimation results for predicting the car ownership response of Dutch households to changes in fixed and variable costs. In this joint model (see Figure 2), we have common income coefficients in the SI parts of the model and the RP part. Furthermore we scale the variance of the random component in the SI models to that of the RP variance, to present 'real world circumstances'. The RP car ownership model has four alternatives: 0, 1, 2 and 3+ cars. Similarly to the DYNAMO (MuConsult 2008) car ownership model, it is a nested logit model (however, DYNAMO stops at 2+ cars). There is a nest with 1 and 2+ cars, and a deeper nest with 2 and 3+ cars.

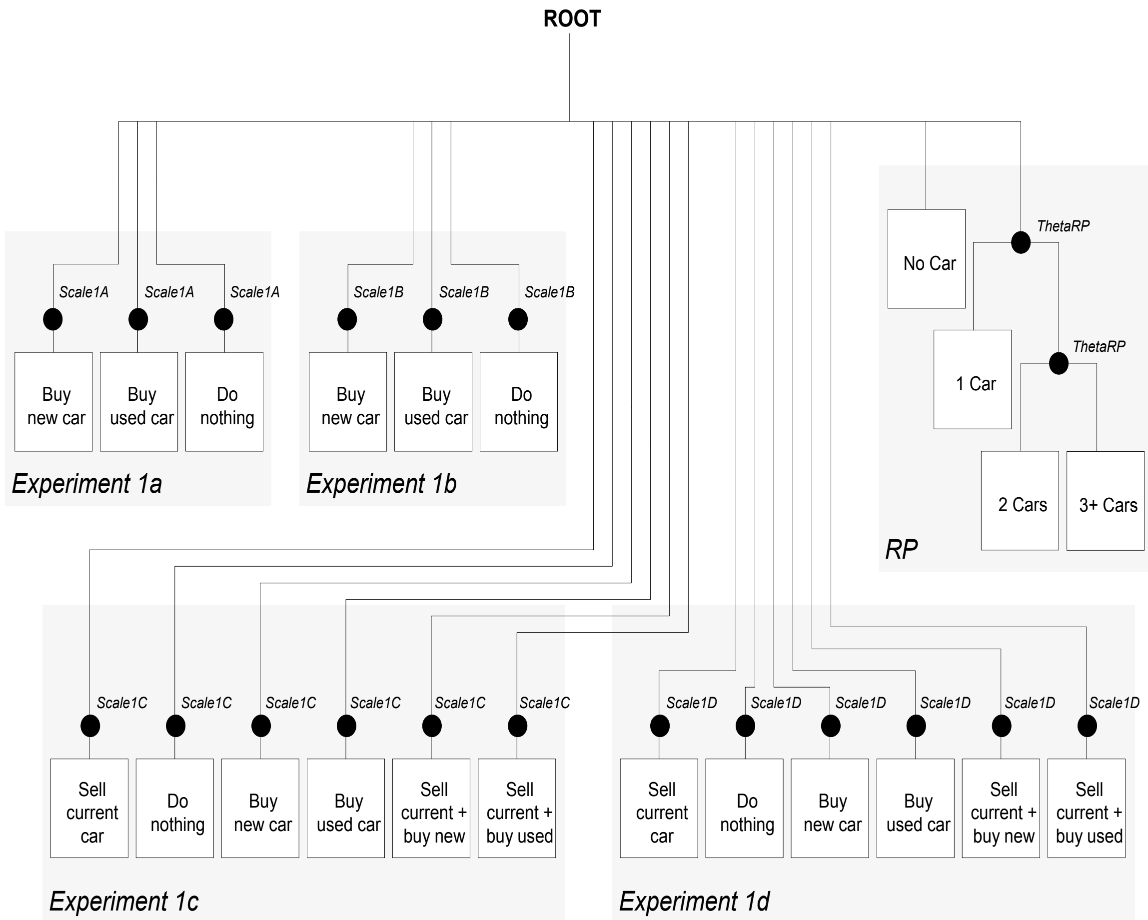
The estimation results are in Annex 3. The fixed and variable costs have the right sign and are significant. Please note that these are fully based on the SI data (in DYNAMO a fixed costs coefficient could be estimated, because the data set contains several years of data, but we have no time series variation here). The coefficient for fixed costs in the joint model comes from the SI models for segment B and D only; the variable costs coefficient comes from all four SI models. The column 'calibration' results refer to the changes in the RP constants to reproduce the observed market shares for the numbers of cars in the Dutch population. The joint model has been used in application to derive elasticities and other demand responses to policy measures (see section 5).

The estimation results (see Annex 3) were obtained using the *Jackknife* method (see Cirillo et al. 2000). This means that many sub-samples were created by leaving out a small part of the data. The model is then estimated on each sub-sample, and after this we calculate the means over the sub-sample results. In the Jackknife estimation for Table 6, we created the sub-samples by each time leaving out another 1% of the households.

Table 2. Household car use in case of 10-30% lower purchase and compensating higher usage cost, relative to observed values

Car transaction	**Segment C**	**Segment D**
Buy an extra car	+11%	+18%
Get rid of a car	-36%	-36%
Replace a car	-19%	-9%

Figure 2. Structure of the joint SI/RP car ownership model



The Jackknife method corrects for the bias that results from using multiple responses from the same respondent as if these would be independent observation (as would be the usual assumption with a sample consisting of a single observation from each respondent). Other methods exist for correcting for this 'repeated measurements' problem, such as the use of respondent-specific components (panel model specification) in the mixed logit model. An advantage of the Jackknife method is that it also corrects for other biases such as bias due to skewed and heteroskedastic distributions. Previous studies using the Jackknife method have shown that usually the model coefficients do not change much, but the *t*-ratios get worse. That is also what we found in this study.

4.4 Impact of the economic crisis

The data collection took place in a time in which the economic climate was quickly becoming more pessimistic. Though in The Netherlands the consequences of the credit crisis have so far not been as severe as in some other countries (such as the U.S. and the U.K.). The car market is one of the sectors hit most badly all over the world. In The Netherlands 2006, 2007 and the first nine to ten months of 2008 were good times for new car sales. But in November 2008, new car sales dropped by 22%, compared to November 2007. For 2009, the car manufacturers association expects that new car purchases in The Netherlands will drop by 6% compared top 2008. This negative economic climate may have an effect on the outcomes of the survey. More specifically it is possible that the increases that we find in car ownership as a result of the variabilisation will be underestimating the car ownership growth that would occur under less pessimistic economic conditions. We also added a question about the effects on car purchases of the economic crisis. The outcomes are presented in Table 3 below. The Table shows that that 7% of the households will postpone purchase (where 9% will buy another car irrespective of the economic climate) and 2% will select a different vehicle type. Similar shares were found in the first and second pilot, which took place early and late November 2008.

Table 3. Answers to the question on the impact of the credit crisis and economic situation on the purchase of new and second hand cars in the next three months

Response	**Frequency**	**% share**
Do not intend to buy another car in coming three months	2034	81.8
Intend to buy another car, and the economic crisis does not affect this	230	9.2
Intend to buy another car but will now choose a different (cheaper) one	50	2.0
Was planning to buy another car, but will postpone this now	174	7.0
Total	2488	100.0

5 Model application

The joint SI/RP car ownership model from Annex 3 was programmed in a spreadsheet model. This model applies the estimated coefficients to the estimation sample (sample enumeration) and then uses a household expansion factor. The expansion factors (by income, household size, car ownership and licence holding) are required to make the estimation sample representative of the population of Dutch households. This program can be used to calculate the effects of changes in both the fixed and variable car costs, separately or in combination (as in the proposed variabilisation measure) on the number of private cars in the Netherlands. The model was used to simulate a number of scenarios (see Table 4). One of these scenarios was to completely abolish the purchase tax BPM. This would reduce fixed car costs by 10.7%. The ensuing kilometre charge would be 4.6 eurocent per km. According to our spreadsheet model, based on the estimates presented in Annex 3, this would lead to an increase in car ownership of 2.2% on the short to medium run (1-5 years).

The spreadsheet model can also be used to derive elasticities. For a change in fixed car cost (including depreciation) we obtain a point elasticity of -0.38. This elasticity is non-linear: it increases (in absolute values) with increasing changes in cost. For a 10% reduction in fixed costs it is -0.42, for a 20% reduction it is -0.48. The variable cost (fuel costs and kilometre charge) elasticity of car ownership in the joint SI/RP model is -0.041. There is hardly any dependence here on the size of the cost change. Table 5 and 6 compare estimated elasticities against those from the literature. The elasticities that we obtain for car ownership are well in line with those from the Dutch national car ownership model DYNAMO (MuConsult 2008). For fixed costs,

Table 4. Simulated changes in private car ownership resulting from changes in fixed car costs and introduction of kilometre charges (in euro).

	Kilometre charge			
Fixed car cost	**3 ct/km**	**4 ct/km**	**4.6 ct/km**	**8 ct/km**
-10%	2.7%	2.3%		0.4%
-10.7%*			2.2%	
-20%	8.0%	7.4%		5.3%
-30%	15.4%	14.7%		12.2%

Table 5. Comparison of fixed and variable car cost elasticities of car ownership

	Effect on car ownership		
	Fixed cost elasticity	Purchase price elasticity	Variable cost elasticity
Blok & Klooster (1989) -NL	-0.1		-0.2
De Jong (1990) - NL	-1.1		-0.8
De Jong (1997) – Norway	-0.8		-0.4
Dargay & Vythoulkas (1999) - UK		-0.3	-0.5[1]
Hanly et al. (2002) – Review of international literature		-0.2 / -0.5[2]	-0.08 / -0.25[2,3]
DYNAMO 2.1		-0.17 (1 year) -0.33 (5 year) -0.45 (20 year)	-0.07 (1 year) -0.13 (5 year) -0.13 (20 year)
This research	**-0.4**	**-0.18**	**-0.04**

[1] Running cost elasticity ; [2] Short term / long term ; [3] Fuel price elasticity

our elasticity is in line with the literature. For variable costs, the literature gives larger impacts on car ownership, but our elasticities of car ownership are not far outside the range. For car use, the fixed cost elasticity fits well in the range give by the literature, but the variable cost elasticity is quite large (but in our case, this was based on a non-significant estimate).

6 Conclusions

This paper presented one of the few empirical studies to examine the effects of both fixed and variable car cost changes on both car ownership and use. An internet survey among Dutch households was designed and conducted including stated intentions and stated preference experiments. We found that in their car purchase decisions, households react more strongly to a euro per year in fixed costs than to a euro per year in variable costs. We obtain this result for car ownership irrespective whether we

Table 6. Comparison of fixed and variable car cost elasticities of car use

	Car use	
	Fixed cost elasticity	**Variable cost elasticity**
Blok & Klooster (1989) –NL	-0.1	-0.1
De Jong (1990) – NL	-0.7	-1.0
De Jong (1997) – Norway	-0.5	-0.8
De Jong and Gunn (2004); Graham & Glaister (2004) - review of international literature		-0.3[1]
Hanly et al. (2002) - review of international literature	-0.2 / -0.4[2]	-0.1 / -0.3[1,2]
Dutch national transport model LMS	0[3]	-0.4[4]
This research	**-0.2**	**-1.2[5]**

[1] Fuel price elasticity; [2] Short term / long term; [3] Effect according to LMS (without iteration with car ownership model); [4] Long-term elasticity; [5] This elasticity is based on a insignificant parameter estimation.

transform monetary attributes to costs per year for the respondents, or leave all attributes in their original non-comparable units. However, the fact that consumers in their decision-making on the number of cars in the household are more sensitive to a euro change in fixed car cost per year than to a euro change in variable car cost per year does not necessarily imply irrational behaviour. Households can decide to pay or not pay fixed car costs by owning or not owning a car, but have to fulfil their travel needs by some means of transport and thus cannot avoid paying distance-based costs. Another reason for finding stronger car ownership reactions to fixed than to variable costs might be the volatility (also recently) in the fuel prices, and maybe also some uncertainty that the respondents feel with respect to the kilometre charge. It is still not certain if it will really be introduced in the Netherlands and if price levels will remain the same. Once a car transaction is agreed upon, the purchase price is certain and one may depreciate this amount over say a car life of ten years. Nevertheless, the fuel prices and the kilometre charge for the next ten years are highly uncertain, and the level now are only a weak indicator of the variable costs in the years to come.

We estimated a household car ownership model jointly on hypothetical and observed choice data. After expansion to the Dutch population, this model gives a fixed car cost elasticity of the number of private cars of -0.4. This is a point elasticity (for very small cost changes). For reductions up to 20% in fixed cost, the elasticity is -0.4 to -0.5. The variable costs elasticity from the same model is -0.04. Therefore, according to the model developed here, abolishing the Dutch car purchase tax while at the same time introducing a kilometre charge will lead to 2.2% rise in car ownership.

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ANNEX 1. Estimation results for car ownership models on SI data

Table A1-1. Car ownership model estimation results on SI data for segment A (currently no car) (Note: n.a. = not applicable)

	Segment A
Observations	4131
Final log-likelihood	-3747.1
Degrees of freedom	14
$\rho^2(0)$	0.192
$\rho^2(\beta)$	0.078

	Alternative 1 BUY NEW CAR		**Alternative 2 BUY 2ND HAND CAR**		**Alternative 3 DO NOTHING**		**Alternative 4 DO NOT KNOW**	
	coefficient	**(*t*-ratio)**	**coefficient**	**(*t*-ratio)**	**coefficient**	**(*t*-ratio)**	**coefficient**	**(*t*-ratio)**
Alternative specific constant	3.599	(7.1)	3.253	(9.3)	0		-0.4257	(-3.4)
Coefficient on purchase price of new car (in €)	-3.16E-4	(-10.4)	*n.a.*		*n.a.*		*n.a.*	
Add. coeff. for households with average age adults 30-39	-0.39E-4	(-5.0)						
Add. coeff. for households with average age adults 40+	0.01E-4	(0.2)						
Add. coeff. for households with income 20,001 – 40,000 €	0.58E-4	(7.4)						
Add. coeff. for households with income 40,001 – 50,000 €	0.92E-4	(8.0)						
Add. coeff. for households with income 50,001 or more €	1.61E-4	(14.8)						
Add. coeff. for households with 2+ worker	0.07E-4	(0.8)						
Coefficient on purchase price of 2nd hand car (in €)	*n.a.*		-4.33E-4	(-10.0)	*n.a.*		*n.a.*	
Add. coeff. for households with 2+ adults			-0.19E-4	(-1.8)				
Add. coeff. for households with 2+ worker			0.52E-4	(4.1)				
Coefficient on km charge (eurocent/km)	-0.087	(-5.7)	-0.087	(-5.7)	*n.a.*		*n.a.*	

Table A1-2. Car ownership model estimation results on SI data for segment B (currently no car) (Note: n.a. = not applicable)

	Segment B
Observations	4158
Final log-likelihood	-3659.2
Degrees of freedom	20
$\rho^2(0)$	0.215
$\rho^2(\beta)$	0.070

	Alternative 1 BUY NEW CAR		**Alternative 2 BUY 2ND HAND CAR**		**Alternative 3 DO NOTHING**		**Alternative 4 DO NOT KNOW**	
	coefficient	**(*t*-ratio)**	**coefficient**	**(*t*-ratio)**	**coefficient**	**(*t*-ratio)**	**coefficient**	**(*t*-ratio)**
Alternative specific constant					0		1.466	(-8.7)
Alternative specific constant if km/yr = 0 - 9999	-0.605	(-0.8)	0.419	(0.8)				
Alternative specific constant if km/yr = 10000+	-0.317	(-0.4)	1.208	(2.3)				
Coefficient on own cost of new car (in €/yr)	-8.86E-4	(-6.1)	2.31E-4	(2.3)	*n.a.*		*n.a.*	
Add. coeff. for single female households with no children	-3.56E-4	(-7.0)						
Add. coeff. for single adult households with 1+ children	-1.64E-4	(-2.2)						
Add. coeff. for two adult households with no children	-1.27E-4	(-3.8)						
Add. coeff. for two adult households with 2+ children *or* 3+ adult households with any number children	-1.88E-4	(-4.5)						
Add. coeff. for households with income 20,001 – 40,000 €	2.64E-4	(7.2)						
Add. coeff. for households with income 40,001 or more €	4.59E-4	(11.4)						
Coefficient on own cost of used car (in €/yr)	7.01E-4	(3.9)	-7.64E-4	(-5.8)	*n.a.*		*n.a.*	
Add. coeff. for households with average age adults 30+			-0.95E-4	(-3.6)				
Add. coeff. for single female households with no children *or* single adult households with 1+ children			-1.86E-4	(-5.7)				
Add. coeff. for three adult households with 1+ children			2.31E-4	(2.9)				
Add. coeff. for households with income 20,001 or more €			1.77E-4	(6.1)				
Coefficient on usage cost (in €/yr)	-0.87E-4	(-2.7)	-0.87E-4	(-2.7)	*n.a.*		*n.a.*	

Table A1-3. Car ownership model estimation results on SI data for segment C (currently car-owning) (Note: n.a. = not applicable)

	Segment C
Observations	6894
Final logl-ikelihood	-7964.2
Degrees of freedom	28
$\rho^2(0)$	0.358
$\rho^2(\beta)$	0.031

	Alternative 1 GET RID OF CURRENT CAR		**Alternative 2** KEEP CURRENT CAR		**Alternative 3** KEEP CURRENT + BUY NEW		**Alternative 4** KEEP CURRENT + BUY 2nd HND		**Alternative 5** GET RID OF CURRENT + BUY NEW		**Alternative 6** GET RID OF CURRENT + BUY 2nd HND		**Alternative 7** DO NOT KNOW	
	coeff.	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**
Alternative specific constant	-2.520	(-19.0)	0		-1.683	(-2.0)	-2.116	(-3.1)	0.715	(1.5)	0.069	(-0.2)	-1.010	(-5.6)
Coeff. on own cost of new car (in €/yr)	*n.a.*		*n.a.*		-1.15E-4	(-2.3)	*n.a.*		-2.20E-4	(-9.0)	*n.a.*		*n.a.*	
Add. coeff. 1 female hh. w/ no children *or* 1 adult hh w/ 1+ children					0				-0.23E-5	(-2.4)				
Add. coeff. 2 adult hh w/ no or 1 child.					0				-0.16E-4	(-2.9)				
Add. coeff. 2 adult hh w/ 2+ children					0				-0.48E-4	(-5.8)				
Add. coeff. 3+ adult hh w/ no children					0.69E-4	(6.0)			0					
Add. coeff. hhs. w/ inc. 20,001–40,000 €									0.31E-4	(4.9)				
Add. coeff. hhs. w/ inc. 40,001–50,000 €									0.37E-4	(4.4)				
Add. coeff. for hhs w/ inc 50,001+ €									0.53E-4	(8.2)				

Table A1-3. Car ownership model estimation results on SI data for segment C (currently car-owning) (Note: n.a. = not applicable) (continued)

	Alternative 1 GET RID OF CURRENT CAR		Alternative 2 KEEP CURRENT CAR		Alternative 3 KEEP CURRENT + BUY NEW		Alternative 4 KEEP CURRENT + BUY 2nd HND		Alternative 5 GET RID OF CURRENT + BUY NEW		Alternative 6 GET RID OF CURRENT + BUY 2nd HND		Alternative 7 DO NOT KNOW	
	coeff.	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**
Coeff. on purch. price 2nd hand car (in €)	*n.a.*		*n.a.*		*n.a.*		-2.80E-4	(-2.5)	*n.a.*		-2.13E-4	(-5.2)	*n.a.*	
Add. coeff. 1 female hh. w/ no children							1.29E-4	(1.7)			-1.61E-4	(-8.2)		
Add. coeff. 1 adult hh w/ 1+ children							1.29E-4	(1.7)			-1.61E-4	(-8.2)		
Add. coeff. 2 adult hh w/ no children							1.29E-4	(1.7)			-1.36E-4	(-9.1)		
Add. coeff. 2 adult hh w/ 1 child							1.29E-4	(1.7)			-0.70E-4	(-3.9)		
Add. coeff. 2 adult hh w/ 2+ children							2.27E-04	(3.1)			-1.25E-4	(-8.4)		
Add. coeff. 3+ adult hh w/ no children							2.27E-04	(3.1)			-1.25E-4	(-8.4)		
Add. coeff. 3+ adult hh w/ 1+ children							2.27E-04	(3.1)			-0.92E-4	(-4.9)		
Add. coeff. for hhs w/ inc 30,001+ €											0.74E-4	(8.4)		
Coeff. on trading value (frac. of curr. val.)	*n.a.*		*n.a.*		*n.a.*		*n.a.*		1.390	(4.1)	1.390	(4.2)	*n.a.*	
Coefficient on km charge (eurocent/km)	*n.a.*		-0.081	(-2.8)	-0.081	(-2.8)	-0.081	(-2.8)	-0.081	(-2.8)	-0.081	(-2.8)	*n.a.*	
Add. coeff. for households w/ 1 worker			0.092	(4.0)	0.092	(4.0)	0.092	(4.0)	0.092	(4.0)	0.092	(4.0)		

Table A1-4. Car ownership model estimation results on SI data for segment D (currently car-owning) (Note: n.a. = not applicable)

	Segment D
Observations	6831
Final log-likelihood	-8329.0
Degrees of freedom	32
$\rho^2(0)$	0.323
$\rho^2(\beta)$	0.019

	Alternative 1 GET RID OF CURRENT CAR		Alternative 2 KEEP CURRENT CAR		Alternative 3 KEEP CURRENT + BUY NEW		Alternative 4 KEEP CURRENT + BUY 2nd HND		Alternative 5 GET RID OF CURRENT + BUY NEW		Alternative 6 GET RID OF CURRENT + BUY 2nd HND		Alternative 7 DO NOT KNOW	
	coeff.	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**
Alternative specific constant													-0.385	(-1.7)
Alt. spec. const. if km/yr = 0 – 9999	-1.767	(-22.3)	0		-2.576	(-23.2)	-3.329	(-20.9)	-1.572	(-2.9)	-0.307	(-0.7)		
Alt. spec. const. if km/yr = 10000 - 19999	-1.157	(-3.6)	0.937	(2.9)	-2.137	(-6.3)	-2.137	(-6.3)	-0.563	(-0.9)	0.304	(0.6)		
Alt. spec. const. if km/yr = 20000+	-0.834	(-2.1)	1.380	(3.6)	-1.310	(-3.3)	-1.377	(-3.4)	0.061	(0.1)	1.071	(1.8)		
Coeff. on own cost of new car (in €/yr)	*n.a.*		*n.a.*		*n.a.*		*n.a.*		-4.76E-4	(-3.0)	*n.a.*		*n.a.*	
Add. coeff. 1 female hh. w/ no children									2.64E-4	(2.8)				
Add. coeff 1 adult hh w/ 1+ children									-5.52E-4	(-1.7)				
Add. coeff. 2 adult hh w/ 1 child.									3.84E-4	(3.9)				
Add. coeff. 2 adult hh w/ no or 2+ child.									2.64E-4	(2.8)				
Add. coeff. 3+ adult hh w/ no children									2.64E-4	(2.8)				
Add. coeff. 3+ adult hh w/ 1+ children									3.84E-4	(3.9)				
Add. coeff. hh w/ average age adults 40+									-0.70E-4	(-2.5)				
Add. coeff. for households w/ 1 worker									-1.63E-4	(-4.1)				

Table A1-4. Car ownership model estimation results on SI data for segment D (currently car-owning) (Note: n.a. = not applicable) (continued)

	Alternative 1 GET RID OF CURRENT CAR		Alternative 2 KEEP CURRENT CAR		Alternative 3 KEEP CURRENT + BUY NEW		Alternative 4 KEEP CURRENT + BUY 2nd HND		Alternative 5 GET RID OF CURRENT + BUY NEW		Alternative 6 GET RID OF CURRENT + BUY 2nd HND		Alternative 7 DO NOT KNOW	
	coeff.	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**
Coeff. on own cost 2nd hand car (in €/yr)	*n.a.*		*n.a.*		*n.a.*		*n.a.*		*n.a.*		-5.04E-4	(-4.0)	*n.a.*	
Add. coeff. 1 female hh. w/ no children											1.51E-4	(5.0)		
Add. coeff. 1 adult hh w/ 1+ children											0			
Add. coeff. 2 adult hh w/ no children											1.51E-4	(5.0)		
Add. coeff. 2 adult hh w/ 1 child											1.51E-4	(5.0)		
Add. coeff. 2 adult hh w/ 2+ children											2.97E-4	(8.4)		
Add. coeff. 3+ adult hh w/ no children											0			
Add. coeff. 3+ adult hh w/ 1+ children											0			
Add. coeff. hh w/ average age adults 40+											-1.84E-4	(-7.1)		
Add. coeff. for households w/ 1 worker											-1.18E-4	(-2.9)		
Add. coeff. for households w/ 2+ worker											-2.08E-4	(-5.1)		
Coeff. fixed cost curr. car (frac. curr. val.)	*n.a.*		*n.a.*		*n.a.*		*n.a.*		0.943	(2.7)	0.943	(2.7)	*n.a.*	
Coefficient on usage cost (in €/yr)	*n.a.*		-0.38E-4	(-1.3)	-0.38E-4	(-1.3)	-0.38E-4	(-1.3)	-0.38E-4	(-1.3)	-0.38E-4	(-1.3)		

ANNEX 2. Estimation results for car use

Table A2-1. RP household total car use (km/year) estimation results for segments C and D

Variable	**Estimated coefficient**	**(*t*-ratio)**
Constant	25422	(1.6)
Variable cost (euro/km)	-260701	(-1.4)
Income minus fixed cost (euro/year)	0.558	(4.3)
Dummy for 2 person household	2037	(1.0)
Dummy for 3-4 person household	6678	(2.6)
Dummy for 5+ person household	7492	(2.4)
Dummy for age between 40 and 49	-2552	(-2.1)
Dummy for retired person	-3617	(-1.9)
Dummy for household with children	-4022	(-2.9)
Observations	1525	
$\boldsymbol{\rho^2}$	0.05	
$\boldsymbol{F}$	9.3	

ANNEX 3. Estimation results for car ownership models on SI and RP data

Table A3-1. Estimation/calibration results for car ownership model on SI and RP data

	Estimation results
Observations	24460
Final log-likelihood	-26658.0
Degrees of freedom	64
$\rho^2(0)$	0.287
$\rho^2(\beta)$	0.027

	Alternative 1 BUY NEW CAR		**Alternative 2 BUY 2[ND] HAND CAR**		**Alternative 3 DO NOTHING**		**Alternative 4 DO NOT KNOW**				
	coeff.	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**			
SCALE PARAM. EXPERIMENT 1A	0.444	(3.5)	0.444	(3.5)	0.444	(3.5)	0.444	(3.5)			
Alternative specific constant							-1.949	(-2.5)			
Alt.spec.const. if km/yr = 0 – 9999	4.526	(2.8)	2.732	(2.4)							
Alt.spec.const. if km/yr = 10000+	7.896	(3.0)	3.653	(2.5)							
Coeff. for purchase cost of new car (€)	-6.67E-4	(-3.5)	0.11E-4	(0.4)							
Coeff. for purchase cost of used car (€)	2.12E-4	(2.0)	-6.67E-4	(-3.5)							
Coeff. for variable costs (€)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)							
(Linear) coefficient on income (€/yr)					-0.38E-4	(-10.7)					
SCALE PARAM. EXPERIMENT 1B	0.527	(3.5)	0.527	(3.5)	0.527	(3.5)	0.527	(3.5)			
Alternative specific constant							-3.265	(-3.1)			
Alt.spec.const. if km/yr = 0 – 9999	-3.396	(-2.1)	-1.098	(-1.0)							
Alt.spec.const. if km/yr = 10000+	-2.592	(-1.6)	0.199	(0.1)							
Coeff. for fixed cost of new car (€)	-1.07E-3	(-2.4)	4.30E-4	(2.7)							
Coeff. for fixed cost of used car (€)	1.22E-3	(3.0)	-1.07E-3	(-2.4)							
Coeff. for variable costs (€)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)							
(Linear) coefficient on income (€/yr)					-0.38E-4	(-10.7)					

Table A3-1. Estimation/calibration results for car ownership model on SI and RP data (continued)

	Alternative 1 GET RID OF CURRENT CAR		Alternative 2 DO NOTH. / KEEP CURR. CAR		Alternative 3 BUY NEW (+ KEEP CURRENT)		Alternative 4 BUY 2nd HND (+ KEEP CURRENT)		Alternative 5 GET RID OF CURRENT + BUY NEW		Alternative 6 GET RID OF CURRENT + BUY 2nd HND		Alternative 7 DO NOT KNOW	
	coeff.	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**	**coeff.**	**(*t*-rat.)**
SCALE PARAM. EXPERIMENT 1C	0.237	(3.7)	0.237	(3.7)	0.237	(3.7)	0.237	(3.7)	0.237	(3.7)	0.237	(3.7)	0.237	(3.7)
Alternative specific constant													-4.437	(-0.6)
Alt.spec.const. if km/yr = 0 – 9999	-9.833	(-3.5)	0		-4.789	(-2.1)	-7.419	(-2.4)	-0.626	(-0.3)	-4.012	(-2.3)		
Alt.spec.const. if km/yr = 10000 - 19999	-11.600	(-1.5)	-1.844	(-0.3)	-4.145	(-0.5)	-9.854	(-1.3)	-1.580	(-0.2)	-5.919	(-0.8)		
Alt.spec.const. if km/yr = 20000+	-10.580	(-1.2)	-0.250	(-0.0)	-2.409	(-0.3)	-6.090	(-0.7)	0.293	(0.0)	-2.989	(-0.4)		
Coeff. for purchase cost (€)					-6.67E-4	(-3.5)	-6.67E-4	(-3.5)	-6.67E-4	(-3.5)	-6.67E-4	(-3.5)		
Coeff. for variable costs (€)			-1.48E-4	(-1.3)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)		
Coeff. for trading value current car (€)									5.326	(3.2)	5.326	(3.2)		
(Linear) coefficient on income (€/yr)	-0.25E-4	(-6.0)	-0.25E-4	(-6.0)					-0.25E-4	(-6.0)	-0.25E-4	(-6.0)		
SCALE PARAM. EXPERIMENT 1D	0.395	(1.8)	0.395	(1.8)	0.395	(1.8)	0.395	(1.8)	0.395	(1.8)	0.395	(1.8)	0.395	(1.8)
Alternative specific constant													-1.435	(-0.8)
Alt.spec.const. if km/yr = 0 – 9999	-3.431	(-1.6)	0	(*)	-1.921	(-1.1)	-4.253	(-1.6)	-1.680	(-0.8)	-0.757	(-0.5)		
Alt.spec.const. if km/yr = 10000 - 19999	-2.432	(-0.8)	1.773	(0.7)	-1.172	(-0.4)	-2.027	(-0.7)	0.144	(0.1)	0.391	(0.2)		
Alt.spec.const. if km/yr = 20000+	-1.673	(-0.7)	2.901	(1.1)	0.568	(0.2)	-0.388	(-0.2)	1.384	(0.6)	2.234	(1.0)		
Coeff. for fixed cost (€)					-1.07E-3	(-2.4)	-1.07E-3	(-2.4)	-1.07E-3	(-2.4)	-1.07E-3	(-2.4)		
Coeff. for variable costs (€)			-1.48E-4	(-1.3)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)	-1.48E-4	(-1.3)		
Coeff. for fixed cost current car (€)									1.736	(1.3)	1.736	(1.3)		
(Linear) coefficient on income (€/yr)	-0.25E-4	(-6.0)	-0.25E-4	(-6.0)					-0.25E-4	(-6.0)	-0.25E-4	(-6.0)		